First nesting record of Philippine Eagle *Pithecophaga jefferyi* from Luzon, Philippines, with notes on diet and breeding biology

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Introduction

The Critically Endangered Philippine Eagle *Pithecophaga jefferyi* is one of the world's largest forest eagles and is known to occur only on the Philippine islands of Luzon, Leyte, Samar and Mindanao (BirdLife International 2016). Since its discovery (Ogilvie-Grant 1897), most studies pertaining to the biology of the species have been focused on Mindanao. Exploration of Luzon has led to the detection of adult eagle pairs and young birds; however, no active nest has previously been found. Here we report the first discovery and observation of an active Philippine Eagle nest in 2015 and record the nest characteristics, prey items and breeding biology of the eagles on Luzon. We also report details of what we believe was another Philippine Eagle nest found in 2013.

Fieldwork

We searched for Philippine Eagles and their nests in the northern Cordillera range of Calanasan, Apayao province, Luzon, during intermittent expeditions between November 2011 and April 2015. Our survey sites in the range consisted of predominantly secondary dipterocarp and montane forests in mountainous terrain from 100 to 1,200 m. We divided the 2,592 km^2 study area into a 5 km × 5 km grid map, and systematically selected survey locations based on local reports of eagle sightings and appropriate forested habitat.

Our first success was on 22 March 2013 when we discovered a large stick nest in the interior of montane forest in the northern Cordillera range at 1,098 m. After making sure the nest was empty, we climbed the tree—an almaciga *Agathis philippinensis*, similar to some of the trees used by Philippine Eagles for nesting on Mindanao—using ropes and harnesses. The nest was 1.02 m in diameter and 0.73 m deep, and we judged that it was too big to belong to a smaller Philippine raptor; we had already seen the nests of, for example, North Philippine Hawk Eagle *Nisaetus philippensis* in the same mountainous area, but this nest was significantly larger and we concluded that only Philippine Eagles would build a nest of this size. We also found evidence that the nest had recently been in use: twigs on the nest bowl appeared intact and fresh, whilst foliage and epiphytes surrounding the nest appeared recently torn and had not yet grown over it.

It appeared that the nest had been deliberately located so that it was concealed by the epiphytes surrounding it. It is interesting to note that we had seen a juvenile Philippine Eagle about 3.1 km from this nest-site about a week earlier. However, we have no evidence linking this bird directly to this nest; although the nest was empty, we monitored it for a few months but never saw either juvenile or adult birds return to it.

We surveyed for eagles from vantage points on hilltops and in the canopy of tall trees. When an eagle was detected, we made a systematic ground search for potential nest trees using locations from which they had emerged or where they descended into the forest canopy. After a series of sightings that included a food delivery by one of the adult eagles, we found the active nest on 21 April 2015 and observed it from 29 April to 1 September. The nest was on a densely forested slope of lowland dipterocarp at about 450 m, built at a height of 31 m in the middle canopy of a 2.29 m dbh *Hopea* sp. tree. The nest was surrounded by towering pandan *Freycinetia* sp. epiphytes (in much the same way as the empty nest found in 2013) and was substantially concealed by the thick foliage of an adjacent *Rauvolfia* sp. tree (Plate 1). It was roughly circular in shape, 1.54 m in diameter and 0.5 m deep. Based on the development of nestlings on Mindanao (Kennedy 1977, Ibañez *et al.* 2003, Ibañez 2007), we estimated the age of the chick to be over one month when the nest was found. Hence the egg was probably laid towards the end of January 2015 and hatched around the end of March, indicating that the onset of breeding of Philippine Eagles on Luzon was relatively delayed compared with those on Mindanao.

The 2015 nest site was about 31.45 km north of the disused nest found in 2013, located within an area protected under the 'Lapat' system, an adaptation of traditional indigenous natural resources management (Sadao 2010) by local government and central government offices working together (Local Government Unit [LGU] Calanasan & Community Environment and Natural Resources Office [CENRO] Calanasan 2011).

We recorded nest activity at 10 minute intervals, and also opportunistically recorded rarer events such as practice flights and other noteworthy behaviour when they occurred outside this sampling regime. We followed Marti *et al.* (1987) in computing the biomass of the food items (quantity × weight) and their percentage biomass (individual biomass/total biomass × 100). We also computed the numerical percentage (number/total number × 100). The weights of food items were based on the mean specimen weights published by Kinnaird & O'Brien (2007) and FMNH (2010), plus data provided by E. Sy and B. Santos (unpubl. data).

Philippine Eagles are sexually dimorphic, with females weighing nearly a third more than males. Apart from their size difference, the male and female adults were distinguished from each other through features peculiar to each bird, such as relative size and structure of tarsi, the presence of torn and moulted feathers, and other plumage features.

Nest monitoring results

We monitored eagle activity at the nest and food deliveries to the nest daily using a 20–56× spotting scope from a canopy observation hide located about 60 m away. In total, we spent 977 daytime hours over 92 days up to 1 September monitoring the nest and the eagles' activities. The main everyday activities (89.8%) of the chick recorded from the nestling to the pre-fledging stage were related to general maintenance such as perching, sleeping, preening and defecating (n = 5,267 individual records). Five percent of activities involved feeding by the adults and feeding on its own (n = 294). Other significant activities included vocalising (3.6%, n = 210), object play consisting of grabbing and biting at sprigs (1.3%, n = 75), and flapping exercises (0.4%, n = 18), all of which became more frequent as the chick grew; the chick's developmental milestones are given in Table 1. On 20 July, about two weeks before the nestling began practice flights, the opportunity arose to carefully trap it for examination and to attach a ring and transmitter. Comparison of its size and weight at that time with nestlings of a similar age monitored on Mindanao indicated that it was a female.

We documented a total of 59 food items brought to the nest, consisting of 12 vertebrate species. The two most common were Northern Luzon Giant Cloud Rat *Phloeomys pallidus* and Smooth-scaled Mountain Rat Snake *Ptyas luzonensis*. The cloud rats were also the most important food item in terms of biomass contribution. The rest of the food items were other rat snakes, monitor lizards, macaques, civets and a flying fox. There were also portions of unidentified birds that we suspect were Northern Rufous Hornbills *Buceros hydrocorax* and of unidentified rodents that were most likely to be Philippine Forest Rats *Rattus everetti*. Many items were already decapitated and dismembered so that they

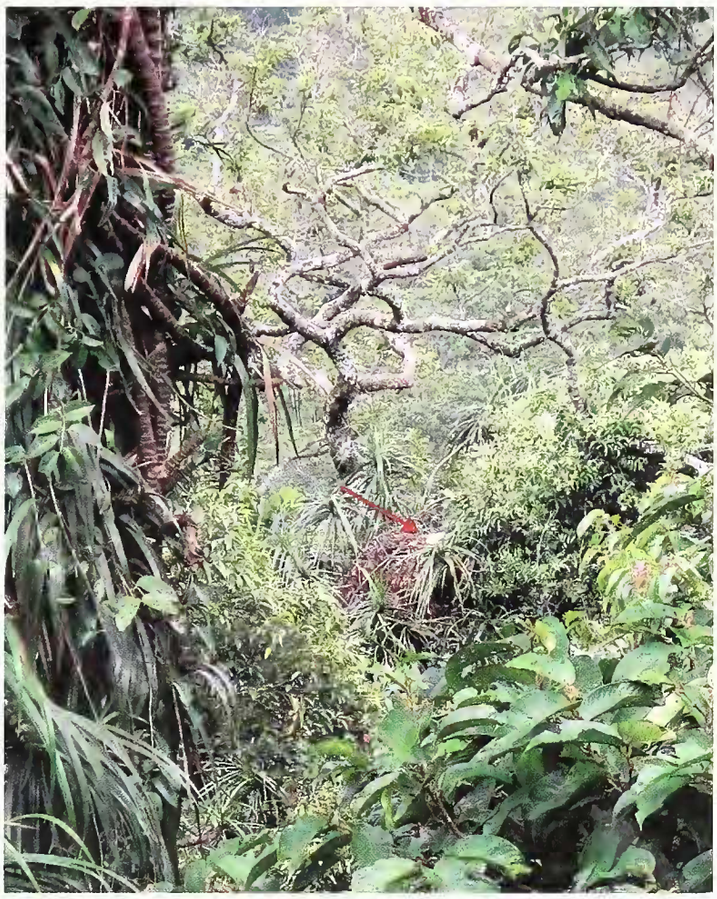

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Plate 1. Philippine Eagle *Pithecophaga jefferyi* nest in the canopy of a *Hopea* sp. tree, 11 May 2015.

could not be identified with certainty. In terms of biomass, mammals (57.6%) made the largest contribution to the chick's diet, but in terms of the number of food items, reptiles made up 37.4%, mammals 32.3%, birds 10.2% and unidentifiable items 20.3% (Table 2).

Discussion

Although we found no significant difference in the placement of the nests compared with those on Mindanao, where the mean nest diameter is 2 m (Gonzales 1968, Kennedy 1985, Ibañez 2007), the nests on Luzon were relatively smaller. This difference in size and the atypical concealment of the nest by surrounding foliage are probably adaptations to protect it from strong winds during typhoons. The egg-laying time on Luzon appeared to be somewhat delayed compared with the typical September–December egg-laying season on Mindanao (Kennedy 1985, Ibañez 2007). This delay is probably another adaptation to cope with the typhoon season—typhoons occur about 80% more frequently on Luzon than on Mindanao (PAGASA 2011) and affect the region more frequently in the period from July to December (PAGASA 2015).

Although, as reported in Table 1, we saw the juvenile flying away from the nest-tree to another tree 100 m away on 26 August 2015, this was not the final time that the juvenile made use of the nest: she continued to return to the nest-tree and to be seen in the close vicinity a number of times after that date. Based on our experience of the behaviour of juvenile Philippine Eagles on Mindanao, we would anticipate that she is likely to finally move away from this area around the end of 2016. Likewise, the same hypothesis—based on Mindanao breeding period observations that, following an incubation period of about two months, a juvenile eagle will mostly reside in or close to its birthplace for a period of around 21 months—may be applied to the young eagle seen in mid-March 2013. It was never seen again in the area close to the recently vacated nest-site that we found on 22 March 2013, implying that if it did originate there it was already on the move when we saw it. If that was the case, its parents may have bred early in 2011 (around January), similar to the 2015 Luzon pair.

Both the Luzon nests were located deep in forest interiors; this is different from Mindanao where the majority of nests are within 100 m of the forest edge (Bueser *et al.* 2003). However, whilst the nest found in 2013 at 1,098 m was well within the known altitudinal range on Mindanao—630–1,434 m (Ibañez 2007)—the 2015 nest at about 450 m is about 200 m lower than previously reported on Mindanao.

Table 1. Summary of the dates on which indicators of the development of the young Philippine Eagle in the Luzon nest were first documented; the estimated hatching date was the end of March 2015

Date	Indicators of juvenile development
1 May 2015	Object plays; weak vocalisations; momentary upright posture; walking with tiny steps
6 May 2015	Flapping exercises
9 May 2015	Feeding independently but with the adult female on the nest
24 Jun 2015	Feeding independently on leftovers without an adult on the nest; improving upright posture, perching and other activities
26 Jun 2015	Feeding independently on fresh prey delivered by the adults
7 Aug 2015	Practising flights out of the nest bowl and hopping and flying from one branch to another in the canopy above
26 Aug 2015	Flight from nest tree to another tree 100 m away

Table 2. Summary of the food items delivered by the adult Philippine Eagles.

Food item	No.	% of total	Weight (kg)	Biomass (kg)	Biomass %
Unidentified prey	12	20.3	–	–	–
Northern Luzon Giant Cloud Rat *Phlaeamys pallidus*	8	13.6	2.6	20.8	22.8
Smooth-scaled Mountain Rat Snake *Ptyas luzanensis*	8	13.6	1.2	9.6	10.5
Unidentified birds	6	10.2	1.8	10.8	11.8
Philippine Water Monitor *Varanus marmaratus*	6	10.2	1.2	7.2	7.6
Reddish Rat Snake *Caelagnathus erythrurus manillensis*	5	8.5	0.3	1.5	1.9
Unidentified rodents	4	6.8	0.5	2.0	2.1
Long-tailed Macaque *Macaca fascicularis*	3	5.1	6.5	19.5	21.3
Palm Civet *Paradaxurus hermaphraditus*	2	3.3	3.0	6.0	6.6
Red-tailed Green Rat Snake *Ganyasama axycephalum*	2	3.3	0.3	0.6	0.8
Malayan Civet *Viverra tangalunga*	1	1.7	4.0	4.0	4.4
Mottle-winged Flying Fox *Desmalapex leucapterus*	1	1.7	0.4	0.4	0.4
Northern Sierra Madre Forest Monitor *Varanus bitatawa*	1	1.7	9.0*	9.0	9.8
Total	59	100.0		91.4	100.0

*based on one specimen only

Plate 2. Adult female eagle feeding young, 6 May 2015.

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Our records of food deliveries to the Luzon nest also revealed important differences between Luzon and Mindanao. In terms of biomass contribution, the Northern Luzon Giant Cloud Rat was the most important prey species on Luzon, unlike Mindanao where the Long-tailed Macaques made up the highest biomass contribution (36.5%). In numerical terms the Northern Luzon Giant Cloud Rat was also one of the top prey species on Luzon, in place of the Philippine Flying Lemur *Cynocephalus volans* and Mindanao Flying Squirrel *Petinomys crinitus*, the most numerous prey items on Mindanao (Kennedy 1985, Ibañez *et al.* 2003, Ibañez 2007); these two species are absent from Luzon. On Luzon, reptiles numerically accounted for 37.4% of the prey items, compared with less than 10% on Mindanao (Kennedy 1985, Ibañez 2007), suggesting a greater variety of available prey on Luzon. Finally, it is noteworthy that no domestic animals were recorded from the Luzon nest, contrary to the observations of Concepcion *et al.* (2006) and Ibañez (2007) on Mindanao.

The differences in both nest location (altitude and habitat) and breeding period discovered during the investigation of this first confirmed breeding record on Luzon suggest that some temporal and range adjustments may be needed in ongoing nest search efforts in the region. More significantly, the noteworthy location of the two nests so far discovered in pristine forest interiors, as well as the apparent variety and sufficiency of wild prey, together strengthen the need to maintain and enhance existing local conservation strategies for the area.

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First record of Yellow-bellied Tit *Pardaliparus venustulus* in Russia suggests a significant range extension of a species formerly endemic to China

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The Yellow-bellied Tit *Pardaliparus venustulus*, classified as Least Concern (BirdLife International 2015), is a species of forests and woodlands previously thought to be endemic to south-east and north-east China (Gosler & Clement 2016). Since 2011, a standardised bird ringing programme has been carried out as part of the Amur Bird Project at Muraviovka Park, Far East Russia (Heim & Smirenski 2013). The Muraviovka Park for Sustainable Land Use (49.874°N 127.704°E) is a non-government-managed nature reserve, about 50 km south-east of Blagoveshchensk, Amurskaya oblast (Heim 2016). It covers 6,500 ha of wetlands with small deciduous forest islands, along the middle reaches of the Amur River.

On 25 September 2013 at 11h00, a juvenile Yellow-bellied Tit was caught in a mist-net located in a deciduous grove close to farm buildings (Plate 1). The following measurements were recorded: wing length 63.5 mm, p8 length 48.0 mm, tarsus length 17.0 mm, bill (to skull) 10.6 mm, fat score 2, muscle score 3, weight 11.0 g. Body feathers were collected for genetic analyses. Body dimensions matched the literature values for *P. venustulus*: wing (of male) 61–68 mm, tarsus 14.2–18.0 mm, weight 9.0–12.5 g (Harrap & Quinn 1996). Whilst this bird was being ringed, a pair of adult Yellow-bellied Tits were photographed near the mist-net (Plates 2 & 3). The ringed bird was recaptured (once) at 10h00 the following day.

The feather samples were used for genetic barcoding analysis with the standard marker cytochrome-oxidase I (COI). DNA was extracted using the sbeadex® forensic kit (LGC Genomics) according to the manufacturer's instructions. Standard bird primers and PCR